Research Proposal Form of the Thesis Entitled

Alveolar bone morphology and its alterations in the Maxillary Central Incisor (MCI) Region for immediate implant treatment planning (IIP) amongst Mumbai Population- A CBCT Analysis

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By

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INTRODUCTION

Immediate implants were first made possible in 1976, and Schulte was the first to implant prosthetic devices into freshly extracted human tissue[1]. Immediate implant placement (IIP) involves placing an implant directly after extracting a tooth. It currently is a popular procedure with accurate, predictable and high success rates.[1] IIP enables us to avoid the waiting period of 4-6 months post-extraction and also helps to prevent crestal bone loss in the bone remodeling phase. The most frequent cause of bone volume loss in both the vertical and horizontal directions is tooth loss in the esthetic zone.[2] Post extraction, the bony socket undergoes remodelling and the height and width of the socket reduce to a considerable extent. This may affect placement of the implant prosthesis and esthetics.[3] It has been suggested that placing implants right after tooth extraction will help to avoid chances of bone loss and preserve the periodontal architecture.[4] Dental rehabilitation of patients with immediate aesthetic needs in the anterior maxillary region has grown steadily in Implant Dentistry. Due to its aesthetic importance, the maxillary anterior region is starting to cause significant concern, because of their unique anatomy, maxillary central incisors are aesthetically sensitive for placement of immediate dental implants.[5] For implant placement, the buccal bone thickness is critical. Ethnic background, occlusion, race, type of facial skeleton and biotype of gingiva all influence alveolar morphology. Stability and integrity of marginal tissue around implants depends on the labial alveolar bone's height and thickness, as well as the incisors' angulation.[6] The esthetic zone is thought to have a number of advantages, such as shorter treatment times overall, fewer operations, less traumatic surgeries, and higher patient satisfaction, Cone Beam CT scan (CBCT) an extremely practical, clinical and helpful technique that offers precise graphical details regarding the oral region inclusive of the quantity and quality of the alveolar bone. CBCT can expose patients to relatively low radiation levels while producing precise and detailed radiographic pictures. When it comes to diagnosing dental problems, planning treatments, and reducing challenges among numerous therapies like tooth removal and implants, CBCT is a crucial tool.[7] Preoperative research and planning are crucial for the treatment's success[8]. This is crucial in situations involving the anterior aesthetic zone. The size and presence of the buccal undercut located in the anterior segment of maxilla, as well as the alveolar ridge's dimensions, influence implant success and hence will be evaluated using CBCT images.

The study will be carried outto offer data in terms of quantity of residual alveolar bone to give support and stability for IIP in the frontal area of the maxillary region. Due to inadequate planning and an underestimation of the requirement for bony addition,[9] particularly in cases of IIP, resulting in lack of success rates. Planning for immediate implant placements can be compromised by a lack of a standardized operating protocol. Baseline measurements of the bone surrounding the maxillary central incisor region, which is a frequent location for immediate implant placement, must be established in terms of the various parameters that will be evaluated in our study.[10] Alveolar bone morphology may be impacted by variables like population, gender, and age groups. As a result, the sample size will be evaluated across a range of age groups, genders, and populations in the local region.

This shall be the first study to simultaneously measure 10 different parameters of the alveolar bone morphology and observe the key anatomic variation in the 1050 sample size which impacts IIP.

AIM:

To determine the alveolar bone morphology and its alterations in Maxillary Central Incisor (MCI) region in Mumbai population analyzing data from CBCT scans for immediate implant treatment planning.

OBJECTIVES:

- To compare the variations in alveolar bone morphology in MCI region amid the parameters in males and females.
- To compare the variations in alveolar bone morphology in MCI region amid the parameters in different age groups.
- To propose a classification of bone morphology in the MCI region with bone management techniques for the same which shall be helpful for use in IIP.
- To suggest a standardized protocol to enhance the success rates of IIP in MCI region.
- To suggest clinical guidelines which will assist clinicians avoid failures of IIP in MCI region.

HYPOTHESIS

1. Generated hypothesis

- Males have thicker bone as compared to females which can be quantified based on the 10 study parameters.
- Early Adulthood individuals have thicker bone as compared to other age groups.
- Mumbai population group has compromised, thinner and deficient bone as compared to other study populations.
- Compromised bone will require an increased number of bone and soft tissue augmentation therapies.

2. Null hypothesis

- Variations do not exist in bony morphology of the alveolar bone in MCI region amid the parameters compared gender wise and amidst contrasting age brackets.

REVIEW OF LITERATURE

1. Wenjian Zhang et al. (2015)[10]

They observed in Cone Beam Computerized Tomography (CBCT) analysis, males exhibit significantly wider ridge width than females. They concluded that among the anterior maxilla's teeth, the alveolar bone was narrowest among the upper lateral incisors with buccal undercuts being frequently found in this region and should be taken in consideration for IIP.

2. Duoling Xu et al. (2016)[11]

The authors studied the association between the sagittal section in the MCI root angulation and the housing of alveolar bone utilizing CBCT in 934 Chinese adults. They observed that the MCI region, most typical sagittal root position is buccal. The proposed classification given by the researchers in the study can help aid in planning for IIP in the esthetic zone of the anterior maxilla.

3. Yun-Hoa Jung et al. (2017)[12]

The authors performed a CBCT analysis retrospectively to evaluate the denseness of the facial bony plate and the angle formed by the upper incisors and to assess association among these variables and the locations of the roots of the MCI within the alveolar bone in 398 control and lateral maxillary incisors. It was noticed that the majority of the sample teeth were covered by thin bone facially with the narrowest being in the lateral incisor region. They found strong connections among the thinness of bony housing and the angulation formed by the root within the alveolar bone. They also observed the buccal bone surrounding the incisors being relatively thin.

4. Howard Gluckman et al. (2018)[13]

Their observational, clinical study created a novel categorization system for the placement of teeth in the anterior part of maxillary region for guidance in IIP utilizing CBCT scans of 150 subjects. They found that palatal walls were typically thin. They also observed that 83% and 92% of teeth had thin facial bony walls (less than I mm) at the crest and midroot respectively.

5. Dina F. Ahmed et al. (2019)[14]

They investigated the dimensions and shape of the upper front teeth for IIP treatment planning using 112 CBCT scans. The bone was thinnest along the alveolar ridge closest to the lateral incisor at all three levels. Lateral incisor area was the area showing frequent occurrences of buccal undercuts. MCI area possessed shallowest undercut, while the canine region had the deepest. Furthermore, Type, I (bell-shaped) shapes were more common in males than in females, whereas Type II (trapezoid-shaped) and Type III (hourglass-shaped) shapes were more common in females. They also gauged the alveolar height, width, occurrence, dimensions of buccal undercuts assessing the cross sectional shape of the alveolar bone.

6. Devrim Deniz Üner, et al. (2019)[15]

They utilized 480 CBCT scans to evaluate the thickness of palatal bony plate in the MCI region, 3/6/9 mm apical to CEJ. They found that the denseness of the palatal bony plate was highly insufficient independently for IIP. They also found that women's palatine alveolar bone thickness was less significantly than that of men.

7. Shrestha B. et al. (2019)[16]

They utilized CBCT to examine denseness in facial bony walls of the maxillary frontal region in 150 Nepalese adults. The distance between CEJ and crest of alveolar bone was also measured. They found that in frontal maxilla, the labial bony plate is naturally slender. Researchers conducted that tissue adaptation is suggested to get an aesthetic smile especially for MCI implants in IIP cases.

8. Diana Heimes, et al. (2021)[17]

Conducted a systematic review on hypotheses of labial bony thickness (LBT) of atleast 1 mm. 25,452 analyzed teeth from 45 studies and 4324 patients were discovered. LBT values of the maxillary frontal and posterior regions were 0.76 mm. and 1.42 mm. They also conducted a literature search electronically for CBCT measurements in adults.

9. Shefali Phogat et al. (2021)[18]

Observed bone morphology based on the North Indian population to examine and suggest directions for IIP in the anterior maxillary zone. Kan's classification was used to evaluate the association amidst the alveolar bone and the frontal region of the maxilla in CBCT pictures of 100 subjects. They concluded that Class I sagittal root position is commonly found amongst the people of Northern India. This research also highlighted relevance of CBCT to enhance accuracy in IIP cases in the maxillary anterior segment.

10. Wang, Xuewei, et al. (2022)[19]

The authors examined the morphologic characteristics along with denseness of facial alongwith palatal bony plate in upper front segment utilizing CBCT scans of 1824 subjects in Chinese population. The denseness of facial bone, longitudinal root location and tooth inclination was examined. Age-related declines in female buccal ABT were observed. Regardless of gender, the age distribution was noticeably different for the SRP classification. In comparison to the female, the male had anterior teeth that were significantly more inclined. They concluded males have thicker bone compared to females CBCT in important for presurgical treatment planning and the denseness of facial and palatal bony plate differs in age as well as gender.

11. Nuhad A. Hassan, et al. (2022)[20]

They utilized CBCT to ascertain the morphologic variations and also select the best implant treatment for reducing surgical incidents by measuring the labial and total bone thickness at the MCI in relation to gender in Iraqi individuals (n=100). This thickness was measured at crest, middle and apical levels. They found the average thickness of labial bone to be less than 2mm. Thickness varied significantly between males and females. Alveolar bone thickness progressed from crest to apex. Women's bones were thinner than men. This CBCT data can be used to develop and modify the treatment plan in IIP cases for increasing esthetics and success rates in MCI region.

12. Affendi, Nur Hafizah Kamar, et al. (2022)[21]

Discussed in detail in CBCT imaging intheir narrative review to analyze alveolar bone before extraction of teeth especially in IIP. Ideal positioning of implants prevents complications due to buccal tilts. Palatal implant placement is recommended, especially regarding IIP in the frontal area of the upper jaw.It is essential the clinician understands the role of facial bone in order to efficiently treat the patient. Before choosing the treatment plan, it is advisable to assess alveolar bone, palatal bone and angulation of teeth in IIP cases. Correct selection of indicated patients helps lower the rate of surgical misadventures thereby increasing success rates.

METHODOLOGY

1. **Source of Data:** This cross-sectional study will be conducted in 4 zones of Mumbai – South, Central, Western and Eastern via cluster randomized sampling technique. The data will be collected from radiology centers all across Mumbai.
2. **Method of Data Collection:** 1050 MCI's will be analyzed on CBCT scans. Values to be obtained by measuring secondary sources of data (CBCT records).

- **Study Population:** 1050 CBCT samples will be divided amongst 525 Males and 525 Females. They will also be divided into 350 early adulthood, 350 middle adulthood and 350 late adulthood.
- **Age Group Division:** Age group of 18 – 70 years will be divided as -

  Early adulthood - 18 to 40 Years

  Middle adulthood - 41 to 60 Years

  Late adulthood - 61 to 70 Years

- CBCT images will be used to evaluate the dimensions of the alveolar bone and alterations occurring amongst MCI to plan instant implant insertions (IIP) utilizing 10 Different parameters such as-
    1. **Height of Alveolar bone** - The span measured from bony crest till the base of the nasal floor.
    2. **Width of Alveolar bone** – The inter-space measured between buccal and palatal bony plates are quantified at 3 different levels: at crest of bone, tooth root apex and 5 mm. Below the apex.
    3. Span measured from **Cemento-enamel junction (CEJ) to the crest of labial bone.**
    4. **Interproximal bone width**
    5. **Longitudinal root location:** Depending on the location of the apical part of the MCI root in the alveolar bone, it will be categorized as Buccally positioned, Middle positioned and Palatally positioned.
    6. **Tooth Angulation** is measured as the angle between 2 lines (one denoting the center axis of MCI and the other denoting the center axis of the alveolar bone).
    7. **Buccal bone denseness**
    8. **Palatal bone thickness**
    9. **Location and depth of buccal undercuts** – Occurence of buccal undercuts will be evaluated for each sampled MCI. The depth of the undercut will be assessed and the distance between the undercut and the crest of bone will be noted.
    10. **Percentage of teeth with buccal undercut** – It will be calculated as- The quantity of teeth having undercuts in the buccal bony plate divided by the combined quantity of teeth totally assessed multiplied by 100.

3. Inclusion Criteria

- Presence of Bilateral Maxillary Central Incisors
- Age group-18-70 years
- CBCT of the anterior maxilla showing the presence of the maxillary central

incisor recommended for any therapy like dental implant, restorations, pulpectomy or orthodontic purposes.

4. Exclusion Criteria

- Topical conditions that could impact the bony dimensions of the maxillary anterior region, e-g periodontitis ranging from moderate to severe, a cyst or tumor, a historyof trauma, or surgery.
- Innate disease affecting bony metabolism, e.g. Bone related disorders.
- Malformations that could negatively affect the bony width such as upper front teeth that are crowded, removed, protruding, embedded in bone.
- Trauma from occlusion, habits like bruxism, clenching, Class II/ Class III malocclusion.

RESULT/CONCLUSION EXPECTED

- It is expected that males will have thicker bone as compared to females quantified by our 10 study parameters and variables.
- It is expected that the early adulthood group will have thicker bone as compared to middle adulthood and late adulthood aged individuals quantified by our 10 study parameters and variables.
- It is expected that the alveolar bone in MCI region in our population will be compromised, thinner and shorter (deficient dimensions) when compared to Caucasians, American and European populations.
- Thus there exists a comparative increase in the need for hard and soft tissue augmentation and related bone management techniques may be more prevalent in our population when compared to Caucasians, American and European populations.

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